

Manufacturing Science & Technology Center— Welcome to MFG S&T Quarterly

Here at Sandia, manufacturing is the science, technology, and processes to create and manage products throughout their life cycle. Manufacturing "makes things happen." It is the crosscutting process that impacts how products are designed and made more cheaply, more understandably, and better. Therefore, the Manufacturing Science and Technology (MFG S&T) Center provides the tools—processes, models, techniques, etc.—necessary to impact product performance and production at a fundamental level. MFG S&T starts where materials and engineering science and technology leaves off—using that information in a systems fashion, always keeping the "end, the product, in mind." Sandia's manufacturing is focused on low volume, high

complexity, high consequence product. This is a relatively unique and highly specialized category within the larger manufacturing community, but it fills a crucial niche required by both DOE and DoD as the specialized manufacturing supply chain continues to downsize.

Sandia's MFG S&T Center has capability in organic materials (adhesion, encapsulation, foams), thin films, packaging, electronic fabrication, ceramic component fabrication and chemical preparation of the required ceramic powders, machining, meso-machining, metrology, tooling and fixturing, and IT—to name a few. Across these capabilities we perform the spectrum of R-to-D-to-A—Research to Development and Design to Application. Bottom line—we make prototype hard-

ware for the Labs. To this end, we develop new processes and capabilities to better meet our customers' needs. It is our goal to become strategic partners with our customers as they seek to exploit opportunities. We work with customers across all of Sandia's business units.

MFG S&T Center Facts

- 302 employees—213 regular, 89 temporary employees, 4 contractors
- 42 technical staff, 41 technologists, 38 students, 150 trades/trades trainees, 16 administrative and 15 management personnel.
- \$44.5M budget in FY02
- 173,419 sq. ft. in 11 different buildings

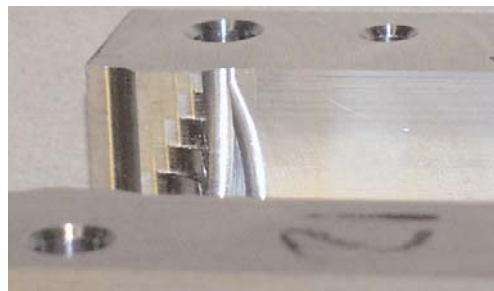
High Speed Machining (HSM)—Better, Faster AND Cheaper

Recently a one-year Production Staging Project (PSP) entitled "*Improved Manufacturing of MC4531 Mold Bodies Using High-Speed Machining (HSM)*" was completed demonstrating the capabilities of HSM at Sandia. The team consisting of Bernie Jokiel, Doug Abrams, Daryl Reckaway, Jim Paustian, Jim Metzler, Monico Lucero and Tony Bryce developed and verified a new machining strategy for neutron generator encapsulation mold designer Mark Sloane. The new process uses HSM to fabricate the aluminum encapsulation molds in less time, with fewer part setups and without the need for secondary hand polishing operations.

HSM is an industry-hardened process to maximize the metal removal rate (MRR) while avoiding tool chatter by taking advantage of the vibrational characteristics of the machining system. Depending on the modal stiffness, mass and damping of the machining system, a chatter-free maximum depth of cut and corresponding spindle speed can be calculated. Such techniques are commonly used in the aircraft industry to machine large monolithic webbed parts from solid aluminum billets replacing larger, heavier riveted sheet metal structures.

Three sets of experiments were conducted to maximize MRR and reduce machining time. Using the results of these experiments twenty-four test molds were machined in 38% less time compared to the original machining strategy (74 minutes versus 119 minutes). Off-machine mold cavity surface finish ranged from 5-14 μ in (8 μ in average), which is well below the required 16 μ in surface finish (top right). Cavity tolerances also were well within their respective design specifications (length: -0.0023" to +0.0032",

(High Speed, Continued on page 2)



During the original process, certain geometrical complexities made it difficult to control tool chatter and gouging (top); the new HSM strategy solves these difficulties (bottom).

Tech Updates

Science-Based Applied Research Helps to Resolve Production Problem

Fundamental understanding of electrically induced strain development during a hot poling process has helped to resolve the hot pole cracking problem for current stack and voltage bar productions. An unusual field-enhanced deformation near the ferroelectric phase transformation temperature in lead zirconate titanate ceramics was observed. The unusual behavior contributed to low production yields in the past few years. Adjusting the poling temperature to prevent the development of this field-enhanced behavior has created an immediate boost in production yield. Results have led to a no-cost process change that eliminates the potential need for costly design changes to current stacks. Data show that production yield has improved from 68% to greater than 95%, which significantly reduces production cost (~ \$40K/lot, or > \$160K/year) and minimizes the impact of our delivery schedule. The boosting of production yield provides additional labor resources for the fabrication of other active ceramic components.

—Pin Yang, George Burns, Roger Moore, Ron Stone, and Mike Hutchinson

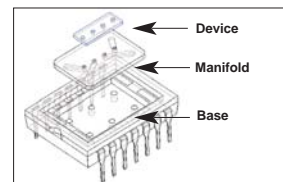
Converging on Standard Packaging Solutions

On June 26, Gilbert Benavides and Rene Gonzales hosted a seminar for Sandians involved in bio/microfluidic-related technology programs. The seminar, involving 18 participants from five different centers within SNL, had three objectives: (1) to introduce and discuss methods available for packaging Sandia developed electro-microfluidic devices, (2) to minimize technology duplication and (3) to outline a suite of "standard" packaging methods for various applications. Jon Custer, Gil Benavides, Doug Adkins, Ron Manginell, and Murat Okandan gave technical presentations on electro-microfluidic packaging solutions and technologies, which were followed by an open discussion.

Blake Simmons and Linda Domeier from SNL, CA held a follow-on seminar September 18 at SNL, NM entitled, "Polymer Replication and Assembly of Microfluidic Devices". They presented their work on hot embossing and injection molding of meso-scale fluidic devices and presented new thermoplastic materials and methods for joining layers of thermoplastic.

The seminars were successful in increasing the awareness of packaging methods available for electro-microfluidic devices, and helped identify potential teaming opportunities. One outcome was a partnering opportunity where SNL, CA

will fabricate standard packaging parts to be used in the "Meso-scale controlled microfluidic drop ejector" project at SNL, NM. Another outcome was a request from a customer in Intelligent Systems & Robotics Center for the MFG S&T Center to fabricate 100 Electro-Microfluidic Dual In-line Packages (shown at right).



An EMDIPTM package allows electrical signals and multiple fluids to be distributed to a MEMS electro-microfluidic device.

For more information contact Gilbert Benavides (505-844-6308, glbenav@sandia.gov) or Rene Gonzales (505-844-2882, rmgonza@sandia.gov). Or visit the electro-microfluidic packaging site at http://mfgtech.sandia.gov/1400_int/14184_int_StndPkg.htm.

New Programs

SNL RAMP—MEP Partnership

Sandia National Laboratories signed a Memorandum of Understanding with the New Mexico Manufacturing Extension Partnership (MEP) on manufacturing technology development and business assistance. Sandia's Regional Alliance for Manufacturing Project (RAMP) is focused on increasing the number of R&D collaborations in manufacturing with regional universities and building a strong supplier base in the low volume, high complexity and high consequence manufacturing environment critical to Sandia's business units.

MEP is part of a nationwide network of more than 70 not-for-profit centers, linked together through the Department of Commerce's National Institute of Standards and Technology, that provide small and medium-sized businesses with the help and solutions they need to succeed. This makes it possible for even the smallest firms in New Mexico to have access to more than 2,000 manufacturing and business specialists.

For more information contact Cesar Lombana (505-284-4582, calomba@sandia.gov)

High Speed Machining

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width -0.0004" to +0.0019", depth 0.0002" to 0.0014"). The decrease in machining time alone accounts for a 20% decrease in the total cost of the molds compared to the original machining strategy.

Using HSM spindle speed tuning techniques one can tune a standard set of tools for each computer numerically controlled (CNC) machining center on the shop floor for commonly machined materials. Spindle speed and maximum chatter-free depth of cut information can be used in CNC machine programming to create more efficient machining strategies the first time. Potential SNL product applications for HSM include other encapsulation molds requiring high precision surfaces, and lightweight aerospace and satellite components.

—Bernie Jokiel and Daryl Reckaway

For more information contact Bernie Jokiel (505-284-4285, bjokiel@sandia.gov) or Doug Abrams (505-844-1124, dgabram@sandia.gov).

4th Axis Addition to LENS®

Sandia National Laboratories has developed a new technology to fabricate three-dimensional metallic components directly from computer-generated models. This process, called Laser Engineered Net Shaping (LENS®), exhibits enormous potential to revolutionize the way in which metal parts, such as complex prototypes, tooling, and small-lot production items, are produced.

The process fabricates metal parts directly from the CAD solid models using a metal powder injected into a molten pool created by a focused, high-powered laser beam. Simultaneously, the substrate on which the deposition is occurring is scanned under the beam/powder interaction zone to fabricate the desired cross-sectional geometry. Consecutive layers are sequentially deposited, thereby producing a three-dimensional metal component.

Parts have been fabricated from stainless steel alloys, nickel-based alloys, tool steel alloys, titanium alloys, and other specialty materials; as well as composite and functionally graded material deposition.

The LENS® team has successfully implemented the addition of a fourth axis. This new axis, configured as a rotary axis and fully integrated into the CNC controller used to drive the XYZ axes, allows for the selective addition of metal in a manner akin to a "reverse lathe" operation. While the additional axis was originally designed and implemented to assist with modification of a braze fixture used for weapon component production, the additional flexibility provided by this axis is currently supporting various internal and external programs for: 1) complex, high aspect ratio feature deposition, 2) improved casting repair, 3) enhanced material performance, and 4) reduced material usage.

For more information contact: Michelle Griffith (505-284-2096, mlgriff@sandia.gov) or David Gill (505-844-1524, ddgill@sandia.gov)



Overall view of LENS system with 4th axis



This auger could not be made without the 4th axis

Kudos

Pin Yang was recently elected Treasurer of the New Mexico Section of the American Ceramic Society. He also participated as an NSF Panel Reviewer related to Environmental Issues in Thin Film Processing for the Product Realization and Environmental Manufacturing Innovative Systems for Eco-Efficiency program. Finally, he served as a session chair at the 104th Annual Meeting of the American Ceramic Society.



Pin Yang

Guy Prevost, of the Organic Materials Department, recently received the Outstanding Technical Student Intern Award (year-round) for 2002. Guy is currently a Senior in Mechanical Engineering at the University of New Mexico. He has worked in the Organic Materials Department since May, 2000 and has made substantial technical contributions to programs such as EnRad, BDYE, and several LDRDs. There are approximately 450 year-round students at SNL, but only 35 were nominated for the Outstanding Technical Student Intern Award. Guy was selected as the winner based upon his performance, job knowledge, task management, teamwork, and communication skills. He received his award at 7th Annual Student Internship Symposium Awards Banquet on August 1, 2002.



Guy Prevost

Insider News

Floating Licenses Now Available

Software that is not part of Sandia's standard packages can be very expensive to buy and maintain. Center 14100 had about 20 stand-alone licenses for SolidWorks CAD software, and frequently someone without a license needed to use the software. While there are ways to move licenses around, it is neither efficient nor productive, since it is time consuming and involves taking a license away from someone else. Buying a new license whenever someone needs one is no better, since these licenses could be unused after the initial need, and this represents a waste of money.

The best way to handle this situation is to have floating licenses available to everyone who needs the software. As long as the number of users does not exceed

the number of available licenses, work continues without interruption, and an excessive number of licenses need not be purchased. From the licenses that Center 14100 owned, we took 10 and converted them to floating licenses and placed them on a server which is available to all the users. So far, 22 users have access to those licenses, and at no time has anyone been denied a license due to high demand.

This represents a savings to the center in that more users have access to the software without purchasing additional licenses, and system administration work is lower since license transfers are eliminated. We are currently looking for additional opportunities to improve the efficiency of our software processes.

—Robert J. Hufnagel

Reaping the Rewards of Property Reapplication and Sales

The Manufacturing Science and Technology Center has been working closely with Property, Transportation & Reapplication (10267) over the past two years to reapply or sell equipment that is no longer needed for manufacturing. The partnership began with Gary Swanson (10267) briefing representatives from all departments within the center on his organization's services. Of particular interest was the "Return on Investment for Property" program. Proceeds from sales are returned to the selling organization and in turn those funds can be used to purchase equipment. Individuals from the center have been working one-on-one with Gary, or Mark Kalin (also 10267), to reapply, sell, or trade-in excess

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More Kudos

New Mexico Skills USA

New Mexico Skills USA held its annual State Fall Leadership Conference October 13th, 14th & 15th in Ruidoso, NM. One hundred sixteen students from across the state took part in this concentrated and instructive three day seminar. Three "leaders" took part in this event: Karl Samuelson, and student interns Ward Stoffer and Sharon Gordon.

SkillsUSA is a national organization serving a quarter-million high school and college students and professional members who are enrolled in technical, skilled, and service occupations.

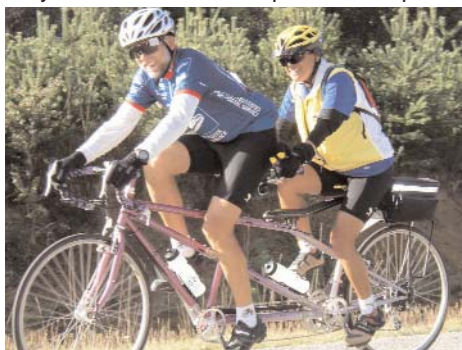
This past June, six Student Interns from SNL's Advanced Manufacturing Trades Training Program went to Kansas City, Missouri to represent New Mexico in the 28th Annual SkillsUSA National Leadership and Skills Conference. Three of these interns competed in different and challenging competitions. Kevin Santistevan competed in Electronics Technology while Reuben Baca competed in Precision Machining. Sharon Gordon placed 2nd and brought home the National Silver Medal in Job Interview Leadership Competition. She was also awarded the \$5,000 True Leader National Scholarship, and was featured in the August 23rd edition of the *Sandia Lab News*. Accompanying the students was SkillsUSA supporter and Chairman of New Mexico State Precision Machining Competition, Thomas Souther, Coordinator, SNL Advanced Manufacturing Trades Training Program.



Attending the SkillsUSA Fall Leadership Conference (left to right) Karl Samuelson, Director Alumni Association; Sharon Gordon, NM President; and Ward Stoffer, State Parliamentarian

Employees Outside Work

Tom Mayer (14171) and his wife Edel recently spent their vacation bicycling in southern France. They rode their tandem bike from Geneva to Nice, on mostly small country roads, through tiny villages, along cliff faces, and over innumerable hills, covering 600 miles and 52,000 ft. of climbing in two weeks. They were joined by about 20 other cyclists, mostly couples on tandems, organized by a commercial tour operator. Despite all of the hills and miles, they had plenty of time to explore the many attractions of the area, including the food, wines, cheeses, breads, pastries, spectacular landscapes, and the hospitality of the French people. Tom and Edel have been riding tandem bikes for about 6 years, including tours in many parts of the US, Italy, and now France. They find it an ideal way to combine exercise, sightseeing, cultural and culinary exploration, and simply spending time together and with friends.



Take Your Sons to Work Day

Many Sandians in Center 14100 participated in the annual "Take Your Sons to Work Day". This event allows boys to observe Sandia's diverse science and technology programs in a hands-on way.

Nicolai Archuleta, a 9th grade student at La Cueva High School said, "It's cool that you actually do the experiments and that the data gets used to fix any flaws or make your project better. It's really hands on—you work with the machinery, and if it needs fixing you do that yourself."



Nicolai and Kim Archuleta

Welcome New Employees

Campbell, Corey B.	14101
Gill, David Dennis	14184
Gill, Timothy J.	14181-2
Tingley, Jeffrey W.	14171

(August-October, 2002)

For more information on the MFG S&T Quarterly, contact Carla Chirigos, 505-845-8645, cdchiri@sandia.gov

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equipment. This partnership has returned over \$115,000 in sales to the Center for purchase of new equipment. New to the process in the past several months is the Bid4assets internet sales program which has expedited sales.

Invest/Divest

The needs of our business environment dictate an investment and divestment strategy for survival and growth. A process was developed and piloted during fiscal 2001. Establishing the process avoided making decisions in a vacuum. It also helped to resolve differences between gut feeling and analysis. Additionally, it built confidence in people that the process was sound and in place as a tool for use in making business decisions.

Four departments participated in the pilot (Electronic Fabrication—14112, Thin Film, Vacuum & Packaging—14171, Mechanical Engineering—14184, and Manufacturing Processing—14181).

The outcome of the pilot resulted in the divestment of forging and led to consolidation of machining equipment. It was also instrumental in continued investment in plating technology and micropen for circuit applications. The investment/divestment process assists in the identification of candidates for the process, outlines process steps supported by a list of questions which when answered should assist management in making a final decision. In fiscal 2002 several more technologies went through the process. As a result, some equipment has been sold with the proceeds benefiting the organizations. Other equipment has been placed in long-term storage (for review on a yearly basis) benefiting the Center by releasing valuable space for other use.

Energy Savings Systems

Currently the hallway sensors (fully operational) are saving about \$3200 per year. The automatic lighting, when completed and programmed (it is 70% complete now), will save an additional \$48k per year.

The water project for the Brazing Lab's furnace for brazing and heat treating is 90% complete and it has been estimated that it will save the same amount of water that Sandia uses in 2 days (2 million gallons). This equates to about \$8000/year in water savings.

All electrical savings are direct electrical meter reductions and result in direct savings to 14100 by reduced monthly space charge back costs via the electrical cost pool.

Water is currently not metered but, due to the potential future cost of water, it may soon be. Indirect water savings are realized by Sandia's total water bill being less, which results in a smaller space chargeback bill throughout the year.

—Mick Gorospe, Building Management (10864)